

would not readily be found in London, where space is so valuable and so fully occupied." And he ended with these observations:—"Corresponding with my own sentiment and experience, I am led to recommend pavement in preference to broken stones for the carriage-ways of the streets of St. George's parish."

Sir John Macneill, C.E., who succeeded Telford, on the London and Holyhead-road (admitted by competent judges to be the most perfect line of turnpike-road in the world), entertained the same opinion, and has corroborated the accuracy of the views propounded by Telford, by a series of experiments made upon road surfaces of different constructions, with an instrument which he had invented for the purpose of testing the friction, or the labour of horses in draught.

The result of his observations, which are recorded in several treatises on roads, and are repeatedly referred to as unquestionable authority, are as follows:

1. On a well made pavement the draught is 33 lbs.
2. On a broken stone surface..... 65 "
3. On a gravel road..... 147 "
4. On a broken stone road, upon a rough pavement foundation..... 46 "

The machine was attached to a waggon, weighing 21 cwt., when the experiments were made.

Sir Henry Parnell, Bart., afterwards Lord Congleton, although occupying an elevated station in society, nevertheless, for the love of the science, made the practical part of road-making his peculiar study, and by constant and unremitting application, rendered himself thoroughly conversant with the most approved systems,—and he entertained similar views to those above stated, as will be seen by reference to his admirable "Treatise on Roads," which is a valuable standard work, and ought to be the text book to all connected with road works. Sir James McAdam, who has greatly distinguished himself as a road regenerator, and rendered great service to his country by the numerous improvements he has been instrumental in carrying into effect on different roads in various parts of the country, has lived to change his views on the subject of the superiority of macadamized roads for the streets of towns; as, in a letter recently published, he admits that the introduction of macadamized roads in the City of London was a complete failure, and that he laments that circumstance ever taking place. "This is the great author and founder of the system. From returns of the relative expenses of macadamized roads and pavements in the City of London, which appeared in the minutes of evidence given on the Westminster Improvement Bill, there is no less a difference, in ten years, than 2l. on every superficial yard: pavement for that time costing 10s. 10d., and macadamized roads, 2l. 10s. 10d.

Mr. James Walker, an engineer of eminence, further corroborated the above opinion in his evidence given before a select committee of the House of Commons on the Commercial Bill. He says: "It is not, I am sure, overstating the advantages of paving, but rather otherwise, to say, taking the year through, that two horses will do as much or more work with the same labour to themselves upon a paved road than three upon a gravelled road, if the traffic upon the gravelled road is considerable; and if the effect of this is brought into figures, the saving of the expense of carriage will be found to be very great when compared with the cost of paving. If the annual tonnage upon the Commercial-road be taken at 250,000 tons, and at the rate of only 3s. per ton from the docks, it could not, on a gravel or stone road, be done under 4s., or one-third per ton difference, which makes a saving of 12,500l. in one year.

I think I am under the mark in all these figures; and I am convinced, therefore, that the introduction of paving would, in many cases, be productive of great advantages."

Sir John Rennie, C.E., in his "History of Engineering," read before the Institute of Civil Engineers during the time he was president, under the head of "Paving," states,— "When the turnpike-road system was introduced, the pavement of the metropolis was improved by the substitution of square blocks of granite, in place of the rounded boulders, or large irregular pebbles, which had previ-

ously been used. Blocks of granite of various dimensions have, by way of experiment, been laid on concrete, with the joints grouted with lime and sand, in order to insure the greatest stability amongst the blocks. McAdam's system was introduced in some streets where the traffic was light, but it did not equal the granite paving."

Mr. Hayward, the surveyor of the City of London Sewers Commission, in the evidence he prepared for the Metropolitan Commissioners of Inquiry, but which was not published in the report, says, that although every kind of road surface had been tried in London, he entertains an opinion in favour of the narrow 3-inch sets as the best road surface under every circumstance, as stated in the report, and which was copied in your journal, No. 353, page 535. Mr. Kelsey, the former City surveyor of London, estimates the expenses of the different descriptions of pavement to vary in the different streets to from 4d. to 3d., or an average of about 1d. per superficial yard per annum.

Mr. Newlands, the borough engineer of Liverpool, in his report on the sewerage and other works of that important borough, enters very fully into the question. At page 85 he observes—"If the streets of a town be unevenly paved, putrid exhalations will arise from the accumulations of filth in the hollows and joints of the stones, which neither the scavenger's brush nor water can remove.

A smooth non-absorbent surface, from which the dirt is easily removed, without hollow or open joints to collect the filth, is what health demands, when it possesses in addition the quality of hardness; and such a surface offers the least resistance to traction.

Tested by this, a macadamized street is the worst that possibly can be made. In such a street the soft absorbent material becomes soaked with liquid filth, which, putrefying, sends its noxious exhalations into the atmosphere. Where there is a great traffic, the road wears so fast as to be constantly under repair, while, by every indentation of the surface, and the laying on of loose materials, the friction is immensely increased. In wet weather it is covered with mud, and in dry weather the air is loaded with the dust of the disintegrated stones mingled with the filth caused by the traffic, producing disease of the respiratory organs, and rapidly deteriorating food and clothing in the houses, and the articles exposed for sale in the neighbouring shops. If to these evils it is added, that a macadamized road is the most expensive to keep in repair, and costs four times as much to cleanse as a paved road, I shall be borne out in saying, that such a road in a town is an expensive nuisance which should be done away with as soon as possible. The next lowest in the scale of roads, both as regards health and traffic, is one formed of boulder pitching. Such a road, from the amorphous forms of the stones, cannot be made with a very even surface; the joints must necessarily be very wide, affording large receptacles for filth; and this irregularity of the bases of the stones rendering it difficult to give them a solid bearing, they are acted upon unequally by the traffic, and ruts and hollows are speedily formed. Streets formed with stones dressed in regular courses are the best; and on sanitary considerations, and also as far as the diminution of friction is concerned, the stones should be smooth and the joints close.

The proper space will be found to be about 4½ inches, of which about 3 inches may be given to the stones and half as much to the joint. To prevent the filth from accumulating in this wide joint, and also to keep the stones steadfast in their places, it should be filled up, nearly flush with the surface of the stones, with some cementitious substances impervious to moisture.

To insure stability, the courses should be made nearly wedge-form; they should be in contact at the base and for about one-third of their height, and the width of the joint should be obtained by diminishing the width of the upper surface of the courses. The joints should be rammed hard with macadam or clean shingle and then filled with a coarse kind of asphalt, composed of the pitch of gas tar and small gravel. A few of the streets of Liverpool have been repaired upon this principle, and, as far as my observations have gone, appear to answer the purpose intended. Mr. Newlands

insists upon a sound and durable foundation being previously prepared. Mr. J. W. Lither, C.E., in a report recently published on the sewage, &c., of Leeds, condemns the system of repairing the streets of that populous borough with small broken stones and round pebble pavement, and suggests the desirability of substituting square-set pavement, as the most economical and healthy for the inhabitants. His plans, I believe, are intended to be carried out by the corporation.

In the populous and important borough of Manchester like opinions are entertained, as the authorities there are gradually extending the system of narrow square-set pavement, so that eventually macadamized roads and round pebble-stone pavement will be entirely superseded.

This pavement, which is composed of sets of Penmanmaw stones, is laid in courses from one inch to one inch-and-a-half asunder, and the cavities between the rows are filled in with small broken stones mixed with gas tar, as suggested and adopted by Mr. Newlands in Liverpool; but I observe by the *Manchester Guardian* that complaints are made that this process renders the surface of the stones slippery to travel over, and if such is the case it will doubtless be abandoned.

It is very generally remarked that the principal streets in Manchester are kept in a better state of repair than those of any town in the kingdom: in fact, they are looked upon as models of street-surfaces by the authorities of the surrounding towns, and I think very properly so, too: this I attribute to their wise policy of discontinuing to use the round pebble pavement, and their abandonment of the self-exploded system of macadamization. In fact, so generally is the system of square set pavement being introduced and extended in the principal towns in the United Kingdom, that multitudes of other instances could be adduced to show the general feeling that prevails even amongst the public at large, without reference to the opinions of scientific men, as to the unsuitableness of small broken stones for the streets of towns, and of the almost equally objectionable round pebble pavement.

I must defer entering minutely into the statistical and practical part of the subject until a future opportunity, when, I doubt not, I shall be enabled to convince those who may be sceptical, that the aid of science may, with great public advantage, be enlisted in the cause of the sanitary and general improvement of our towns, and that we ought not to be led away or retrograde in the onward march, now the spirit of improvement is abroad, by the adoption of the stale and somewhat threadbare theory of "the superiority of macadamized roads for the streets of towns."

BAYLIS.

LINEAR PERSPECTIVE.

In an article upon this subject in the opening number of the present volume of *THE BUILDER*, it may be remembered that I professed solely to answer the objections alleged against the science, as at present received, by a writer in the *Art-Journal*, who had presumptuously declared that it was not true—not to oppose any other scheme that might be presented for notice. In the exposition I then gave, Mr. Heald, of Carlisle, has, in an essay since published in these pages, courteously acknowledged his concurrence. Yet, without proposing a change in the form of the picture, he has introduced an entirely different theory. Now, as in my former papers it was demonstrated that, without this condition, no alteration can be made in the system of perspective, his proposal is an attempt to substitute known and acknowledged imperfection for what, as he himself admits, is really perfect!

But let us examine the system he has advanced, and for which he has instituted so able a defence. Let us do this, and compare it with perspective as now used. When we have done so, the former will not, I think, appear "equally true," nor be found to have "the additional recommendation" either "of greater beauty or a more extended range." He says, that in "cylindrical perspective" "every eye looking at it (the picture) must be in the point of sight." Now, the fact is, no eye can be in the point of sight, for there is no point of